CHAPTER 8

IEEE 1394

This chapter summarizes PC 99 design requirements for hardware designed using the current IEEE 1394 standards. The IEEE 1394 high-speed serial bus complements USB by providing enhanced PC connectivity for a wide range of devices, including consumer audio/video (A/V) components, storage peripherals, other PCs, and portable devices.

IEEE 1394 has been adopted by the consumer-electronics industry and is expected to provide a volume, Plug and Play-compatible expansion interface for the PC. The 100-Mb/s, 200-Mb/s, and 400-Mb/s transfer rates currently specified in IEEE 1394a~~A~~ and the proposed enhancements in IEEE 1394b are well suited to multistreaming I/O requirements.

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Published: April 24, 1997. Printed: 04/24/98 9:51 AM

IEEE 1394 Basic Requirements

The following is a summary of the IEEE 1394 design considerations related to PC systems, as addressed in this chapter:

- Compliance with IEEE 1394 standards, specifically IEEE 1394-1995 and IEEE p1394a
- Support for the 1394 OpenHCI specification for controllers, specifically OHCI Revision 1.0
- Plug and Play support for device configuration, control and status registers (CSRs), connectors and cabling, and connection fault handling
- Cable power distribution, including requirements for source devices, sink devices, self-powered devices, and supporting CSRs
- Device power management, CSRs, and soft-power protocols
- Device command protocols for audio, video imaging, still imaging, and storage device classes

This section defines the basic PC 99 requirements for IEEE 1394.

1. Controllers and devices support mandatory features in IEEE p1394a with backward compatibility with IEEE 1394-1995
Required
Designs that interface to the IEEE 1394 bus must support the following industry standards and supplemental specifications:

- IEEE 1394-1995 standard
- IEEE p1394a, an amendment to IEEE 1394-1995
- ~~IEEE 1212-1991 CSR Format (ISO/IEC 13213:1994)~~IEEE 1212-1991 and function discovery in IEEE 1212-199x.

2. Controllers comply with OpenHCI for IEEE 1394
Required
The 1394 OpenHCI Revision 1.0 specification for IEEE 1394 defines standard hardware and software for PC connections to the IEEE 1394 bus. OpenHCI defines standard register addresses and functions, data structures, and DMA models. The benefits of this standard include improved performance, security, and error handling.

A 1394 OpenHCI device is bus manager-capable, including bus mastering for BANDWIDTH_AVAILABLE and CHANNELS_AVAILABLE registers.

Host adapters and host controllers must implement the mandatory features of 1394 OHCI Revision 1.0, including support for a minimum of four isochronous transmit contexts, four isochronous receive contexts, two asynch transmit contexts, two

asynch receive contexts, self ID context, and physical DMA. ~~Host adapters and host controllers must implement the mandatory features of the 1394 OpenHCI Revision 1.0 specification including support for a minimum of four isochronous contexts, two asynchronous contexts, and physical DMA.~~

Devices that implement 1394 and are not bus managers or bus controllers are not required to implement an OpenHCI-compliant host controller in their Link.

3. OpenHCI controllers and devices support advances defined in IEEE 1394a
Required

The advances in the IEEE p1394a specification enhance system performance and integration of component systems. The mandatory features specified in IEEE p1394a must be supported by all host controllers, peripherals, and Link and PHY components. Mandatory IEEE p1394a features that must be supported by all devices and controllers include:

- 100-400 Mb/s operation of all PHY ports in host controllers
- 100-400 Mb/s operation of all device-side PHYs
- PHY autonomous features for connection debounce and hysterisis
- Arbitration enhancements that promote a high quality of operation and end user experience

4. Host supports peak data rate of 400 Mb/s, minimum
Required

The integration of component systems that enable concurrent applications demands minimum bandwidth for an effective user experience. A peak data rate of 400 Mb/s is required of all host controllers and PHY ports available externally in the system for 1999. The host controller must support 100-Mb/s, 200-Mb/s, and 400-Mb/s data rates as specified in IEEE 1394-1995 and IEEE p1394a. All externally-accessible host controller ports must support S100-400 operation.

5. Design avoids excessive currents resulting from ground-fault potential among devices
Recommended

PC-based peripherals are not required to implement isolation because of the usual assumption of a common green-wire ground for all linked devices. Accordingly, the requirement for electrical isolation has been targeted for removal from the IEEE standard. If optional galvanic isolation is implemented, it should conform to the p1394a specification, which replaces references in IEEE 1394-1995 Annex A and Annex J.6. Power supply, PHY power, connector power, and cable power isolation with appropriate ground returns for signal ground and power "green wire ground" must be observed. Systems that may connect to devices or other systems where a ground fault potential can exist should implement good isolation design practices.

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

Other bodies, such as IEC, UL, and ANSI, govern safety and regulatory considerations for computers, networks, and consumer electronics devices. IEEE 1394 systems and devices should conform to the appropriate safety and regulatory concerns in this area. The exact specification for each class of device or system is outside of the scope of this design guide.~~If optional isolation is supported in a system, it should conform to the IEEE P1394A Annex J implementations. Cable grounding and shielding must be supported.~~

For local area network (LAN) configurations, it is desirable to avoid excessive currents resulting from ground-fault potential among devices. The related design problem can be solved for such configurations by building isolation into the power supply and by AC coupling of the physical layer device (PHY) and Link interface of selective AC-powered subsystems.

~~Notice that a mobile device powered by AC is considered to be an AC device, even with a battery (DC) present. The PC uses this level of definition to budget cable power.~~

Requirements for IEEE 1394 Devices

This section summarizes additional requirements for IEEE 1394 peripherals such as consumer-electronics devices.

6. Device command protocols conform to standard device class interfaces
Required

IEEE 1394 storage class devices must conform to the IEC61883 standards for the CIP (Common Isochronous Packet) format, the CMP (Connection Management Procedures) procedures, and the FCP (Function Command Protocol) protocols.

7. Devices support peak data rate of 400 Mb/s, minimum
~~Recommended~~Required

For PC 99 designs, 400-Mb/s IEEE 1394 devices are recommended; 100-Mb/s devices are strongly discouraged and 200-Mb/s devices should limit their peak bus utilization to less than 50 percent.

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

All systems with external ports and all device PHYs should be capable of 400 Mb/s operation. Note that exisiting devices using only 100 or 200 Mb/s operation are acceptable.

All new peripheral and system designs should use 400 Mb/s PHY ports. In particular, peripherals with more than one port must be capable of transmitting data at 100, 200, and 400 Mb/s through all the ports on the device. ~~For nonhost devices, a 200-Mb/s device with a 160-Mb/s data stream requires 80 percent bus utilization, effectively lowering overall bus bandwidth to 200 Mb/s for 80 percent of the time. Therefore, low bus utilization is required in order for 100-Mb/s and 200-Mb/s devices to coexist with 400-Mb/s peripheral devices. For example, three devices performing at 200 Mb/s each with 30 percent bus utilization would saturate the bus.~~

Also, application bandwidth can be limited by speed traps (that is, a slow device separating two faster devices), imposing speed-dependent cabling considerations on the end user.

All devices that have more than one port accessible must support S100-400 Mb/s operation from their ports to prevent downstream devices from being limited to slower speed operation (known as speed traps). Devices can operate at a lower speed, but all ports should be 400-Mb/s capable.

8. Devices requiring support for high-bandwidth data transfer use IEEE 1394
Recommended

For devices that require support for high-bandwidth data transfers and Plug and Play connectivity, the IEEE 1394 bus is recommended. Such devices include the following:

Component audio
Connectivity peripherals
Digital camcorder
Digital VCR
DTV
DVD-ROM, CD-ROM
Hard disk drives
High-resolution scanners
PC docking stations
Printers
Set-top television controllers
Video conferencing cameras
Archival storage (tape, high density disk, cartridge, or other removable memory media)
Magneto-optical devices

Plug and Play for IEEE 1394

This section summarizes the Plug and Play requirements for IEEE 1394 peripheral devices and PC host controllers.

9. Plug and Play devices demonstrate interoperability with other devices
Required

All devices must support Plug and Play for intended applications in both a minimal and an extended bus configuration. A minimal configuration is the

minimum number of devices necessary to demonstrate the primary application of the device. An extended configuration is an advanced application with at least two devices added to the minimal configuration. The added devices can be extraneous to the application.

The following is a summary of compliance testing guidelines for this requirement:

- Intended applications must be documented before testing.
- Both test configurations must consist of a core matrix of stable devices that have demonstrated full interoperability in the absence of the test device. To be included in the core test matrix, a device must have demonstrated compliance of its PHY, Link, and Transaction layers as specified in the IEEE 1394-1995 and p1394a standards.
- The core matrix of devices must be established by an independent agency with actual testing performed by an independent third party or as part of an industry compatibility workshop.
- IEEE 1394 devices and systems must meet the Personal Computer Compatibility and Interoperability profile, independent of their additional use as peer-to-peer or non-PC devices.
- IEEE 1394 devices must conform to the Plug and Play guidelines as applied to IEEE 1394 devices. For a reference to the Plug and Play guidelines, see "IEEE 1394 References" at the end of this chapter.

10. Topology faults do not cause the bus to fail
Required

Standard IEEE 1394 protocols have been defined to eliminate topology faults. However, to ensure correct implementation, the following items describe test criteria for industry compatibility workshops. In each case, connection or removal of a device must not stall the bus, but the faulting device might not function. The PC must detect each fault. The test criteria include the following:

- Surprise removal. All isochronous-capable devices must support the Connection Management Protocol specified in IEC 61883 (or the most recent specification) in order to resume streaming connections following a bus reset and to de-allocate channels upon surprise removal of a device.
- Safe removal. All devices that provide a front-panel power switch must signal the operating system in response to a local shut-down request (that is, hot unplugging) in order to allow safe removal. Safe removal requires that the end user monitor the PC bus manager's response to the request before removing the device.
- Systems should detect greater than 16 hops. If the bus extends beyond 16 hops or total distance exceeds the maximum cable length and maximum number of nodes/hops, appropriate mechanisms such as PHY pinging and preservation of adequate timing margins must be used. For bus faults generated by cable

delays or scenarios where the bus toplogy exceeds 16 hops, 63 nodes must be detected, reported, and correctable to the end user.

- Greater than 63 devices on a local IEEE 1394 bus. If the 63-device limit is exceeded, the 64th and later devices will be assigned a physical ID of 63. The 64th device must be detected by the bus manager and must provide a warning message to the user.

11. Removable media devices support media status notification
Required

Removable media devices must use an electronic switch to notify the bus manager~~PC~~ in the event of media change requests. This is necessary to enable device applications to lock, unlock, and eject media.

Removable devices must conform to either the NCITS Reduced Block Command (RBC) set standard or the SFF 8090, Revision 2.0, specification.

12. Devices that can initiate peer-to-peer communications also support remote programming
Required

To enhance systems integration, all devices capable of initiating peer-to-peer communications and are designed for use with the PC must also support a programming language that enables remote control for PC applications. This allows a third device, such as a PC or device controller, to initiate data transmission between two devices.

Plug and Play for Device Configuration ROM

This section defines the Plug and Play requirements related to device configuration ROM.

13. Device provides a configuration ROM for unique device identification
Required

For Plug and Play device control, the device configuration ROM must provide configuration information as specified in the ~~IEEE 1394-1995~~Revision 2.0 p1394a standard and as outlined in Table 1 on the~~(see~~ following page~~)~~. The configuration ROM is required for unique detection of the device and is used by a PC to enumerate the bus and to load the correct device driver.

Table 1 provides an example ROM that combines all the elements outlined in the requirements listed in this section. For up-to-date information about the configuration ROM under Windows 98 and Windows NT 5.0, see the web site at http://www.microsoft.com/hwdev/busbios/.

Note to reviewers: Table 1 below has not been updated to reflect the Revision 2.0 p1394a specification. To see the version of the table that will appear in

later revisions of the PC 99 Design Guide, refer to the p1394a Revision 2.0 specification.

Table 1. Example Configuration ROM (located at FFFF F000 0400)

Block	Offset	Description			
First Quadlet	400h	info_length 04h	CRC_length **h	ROM_CRC_value (calculated) **h	**h
Bus_Info Block	404h	‘1394’ in ASCII 31h	33h	39h	34h
	408h	m, c, i, b, p, reserved	cyc_clk_acc	max_rec, reserved	g, rsrvd, link_spd
	40Ch	node_vendor_id **h	**h	**h	chip_id-hi **h
	410h	chip_id-low **h	**h	**h	**h
Root Directory	414h	directory_length 00h	03h	directory_crc **h	**h
	418h	module_vendor_ID key 03h	module_vendor_id **h	**h	**h
	41Ch	node_ capabilities key 0Ch	node_capabilities **h	**h	**h
	420h	unit_directory key D1h	unit_directory offset 00h	00h	01h
Unit Directory	424h	unit_directory_length 00h	03h	unit_directory_crc **h	**h
	428h	unit_spec_id key 12h	unit_spec_id **h	**h	**h
	42Ch	unit_sw_version key 13h	unit_sw_version **h	**h	**h
	430h	unit_dep_dir key D4h	unit_dep_dir offset 00h	00h	01h
Unit Dependent Directory	434h	unit_dep_dir length 00h	04h	unit_dep_dir_crc **h	**h
	438h	vendor_offset key 81h	vendor key offset 00h	00h	04h
	43Ch	vendor_offset key 81h	vendor key offset 00h	00h	0Bh
	440h	model_offset key 82h	model key offset 00h	00h	10h
	444h	model_offset key 82h	model key offset 00h	00h	15h

Note: “**h” indicates information that is filled in by the vendor.

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Block	Offset	Description					
Vendor Leaf (Unicode)	448h	vendor leaf length	00h	07h	vendor_leaf_crc	**h	**h
	44Ch	vendor spec_id	80h	00h		00h	00h
	450h	vendor language_id	00h	00h		04h	09h
	454h	vendor text	4Dh	00h		69h	00h
	458h	vendor text	63h	00h		72h	00h
	45Ch	vendor text	6Fh	00h		73h	00h
	460h	vendor text	6Fh	00h		66h	00h
	464h	vendor text	74h	00h		00h	00h
Vendor Leaf (ascii)	468h	vendor leaf length	00h	05h	vendor_leaf_crc	**h	**h
	46Ch	vendor spec_id	00h	00h		00h	00h
	470h	vendor language_id	00h	00h		00h	00h
	474h	vendor text	4Dh	69h		63h	72h
	478h	vendor text	6Fh	73h		6Fh	66h
	47Ch	vendor text	74h	00h		00h	00h
Model Leaf (Unicode)	480h	model leaf length	00h	05h	model_leaf_crc	**h	**h
	484h	model spec_id	80h	00h		00h	00h
	488h	model language_id	00h	00h		04h	09h
	48Ch	model text	31h	00h		33h	00h
	490h	model text	39h	00h		34h	00h
	494h	model text	00h	00h		00h	00h
Model Leaf (ascii)	498h	model leaf length	00h	04h	model_leaf_crc	**h	**h
	49Ch	model spec_id	00h	00h		00h	00h
	4A0h	model language_id	00h	00h		00h	00h
	4A4h	model text	31h	33h		39h	34h
	4A8h	model text	00h	00h		00h	00h

14. Device configuration ROM implements general ROM format

Required

The general configuration ROM format is specified in the IEEE 1394-1995 and ISO/IEC 13213:1994 standards. The general ROM format is an extensible tree structure that enables a managed environment by providing node-specific and unit-specific information as required for Plug and Play, power management, and isochronous data transfers. The general ROM format also provides for definition of multifunction device units. The bus information block and root directory of the general ROM format are required as specified in Table 1.

15. Bus information block implemented at a base address offset of 0404h

Required

The format of the bus information block is defined by the IEEE 1394-1995 standard. The first quadlet of the bus information block at offset 404h is the configuration ROM signature field used to identify an IEEE 1394 configuration ROM. This quadlet must contain the ASCII string "**1394**." The second quadlet of the bus information block at offset 408h contains several bits that indicate node capabilities. These bits are defined as shown in the following table, together with their required values.

Note: All devices must support the *irmc*, *cmc*, *isc*, *bmc*, and *pmc* bits and, for host controllers, all these bits must be 1.

Bits Indicating Node Capabilities at Offset 408h

Bit or field	Table 1 symbol	Value and description
irmc bit	m	~~Must be 1.~~ Indicates that the node supports isochronous resource manager capabilities.
cmc bit	c	Must be 1 if the node supports cycle master capabilities; otherwise, this value must be 0.
isc bit	i	Must be 1 if the node supports isochronous operations; otherwise, this value must be 0.
bmc bit	b	~~Must be 1.~~ Indicates that the node supports bus manager capabilities.
pmc bit	p	~~Must be 1.~~ Indicates that the node is power manager capable. The *pmc* bit is not defined by the IEEE 1394-1995 standard and is an extension created by this specification.
cyc_clk_acc field	—	Specifies the accuracy of the node's cycle master clock in parts per million. If the *cmc* bit is 1, the field's value must be between 0 and 100. If the *cmc* bit is 0, this field must be all ones.
max_rec field	—	Defines the maximum payload size of a block-write transaction addressed to the node. The range of the maximum payload size is from 4 to 2048 bytes. A *max_rec* value of 0 indicates that the maximum payload size is not specified. Otherwise, within the range of defined payload sizes, the maximum size is equal to

$2^{max\_rec + 1}$. The *max_rec* field does not place any limits on the maximum payload size in asynchronous data packets—either requests or responses—that the node might transmit.

16. Configuration ROM provides globally unique device ID

Required

The third and fourth quadlets of the bus information block of the configuration ROM must provide a globally unique device ID, which appears in Table 1 beginning at offset 40Ch. This unique 64-bit node ID is the only way to recognize the presence of a given device, because the physical device addresses can change following a bus reset. The unique ID is required for device detection and PC device driver loading.

If a bus node supports multiple units, then the unique 64-bit ID must not be referential to any one unit directory in order to allow for unique identification of a unit in a multifunction device.

The globally unique device ID in the bus information block must be invariant when read with quadlet read requests. That is, it must not be alterable in any way by software.

17. Root directory is located at a fixed address following the bus information block

Required

The root directory must be located at a fixed address following the bus information block. For example, the root directory shown in Table 1 is fixed at offset 414h. All other directories and leaves are addressed by entries in their parent directories starting with the root directory. The root directory contains pointers to the root-dependent directory, a node-power directory as specified in *1394 Specification for Power Management*, and unit directories for each independent device function.

18. Configuration ROM includes a unit directory for each independent device function

Required

A unit directory is required for independent function and control of each device unit. A valid pointer to a unit directory must be provided at offset 0x24h, as shown in Table 1, in compliance with the general ROM format specified in IEEE 1394-1995 and the directory format specified in ISO/IEC 13213:1994.

19. Each unit directory provides a valid Unit_Spec_Id and Unit_Sw_Version

Required

Within a unit directory, Unit_Spec_Id identifies the specification authority, and Unit_Sw_Version identifies the particular document describing the unit. When added to the beginning of Unit_Spec_Id, then Unit_Sw_Version uniquely identifies the unit's software interface.

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

20. Each unit directory provides a pointer to a unit-dependent directory

Required

The unit-dependent leaf directory must provide additional information about the device unit's vendor and model in associated leaf directories. The format of the information contained in the vendor and model leaves is specific to Unit_Spec_Id and Unit_Sw_Version.

A valid pointer to a unit-dependent directory must be in accordance with the generic directory format specified in ISO/IEC 13213:1994. The unit-dependent directory must provide valid pointers to vendor and model leaves.

21. Vendor and model leaves support textual descriptor leaf format

Required

Textual descriptors are required for Unit_Spec_ID and Unit_Sw_Version entries in the configuration ROM in order to display this information to the user. Textual descriptors are recommended for all other configuration ROM entries. Each textual descriptor points to a leaf that contains a single character string.

Alternately, the textual descriptor can point to a directory that points to one or more textual descriptor leaves corresponding to supported languages. Leaf format and textual descriptor leaves are specified in ISO/IEC 13213:1994.

Textual descriptor leaves must include the following:

- The spec_type field must be "0" to correspond to a 24-bit specifier_id for a standards body, or "1" to correspond to a 24-bit specifier_id for a defining vendor company_id.
- The language_id field must be derived from the Windows NT locale number (a quadlet), OR'd with 0x80000000.
- Text string_info must be in ASCII for any language_id in the range 0–7fffffff or in Unicode for any language_id in the range 0x80000000–0xfffffff.

22. Unit-dependent directory provides a pointer to the unit's CSRs

Required

Each unit's CSRs must be in separate, non-overlapping address spaces to maintain independent device control. If CSRs can be used to interact with a device unit, the unit-dependent directory must provide a pointer to the base address of the unit's CSRs. This provides an easy way for an application or a device driver to access the unit's CSRs.

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Plug and Play for Cabling and Connectors

This section defines the Plug and Play requirements for IEEE 1394 cabling and connectors.

23. Device provides more than one connector port
Recommended

~~All~~ D~~d~~evices should provide at least two (preferably three) 6-pin connector ports for optimum cabling options, subject to cable-power distribution constraints. Fewer than three ports promotes long daisy chains, increasing the potential for speed traps (a slow device separating two faster devices). Therefore, three-port IEEE 1394 device nodes are recommended, with exceptions noted in the “Device uses standard 6-pin IEEE-1394 connector” requirement later in this section.

For internal-only devices, a minimum of two ports enables daisy chaining of devices. However, a limit of 15 hops (end-to-end distance) restricts total devices to 16, sufficient for most internal configurations.

Single port devices are permissible, but it is recommended that devices provide more than one port to enable connectivity to other peripherals when the system does not provide mutiple ports.

Devices that consume cable power should be limited to a single connector to encourage short source-to-sink power delivery while eliminating the build up of voltage drop associated with a long daisy chain of power consumers.

24. Device uses the approved IEEE 1394 connectors
Required

~~A single connector eliminates unnecessary choices for the end user. For every *n* supported connector, there are 2^{n-1} cable choices. Two connector styles yield three end-user cable choices.~~

If the device implements a 4-pin connector, it should be a single port, leaf device because the connector cannot pass cable power to other devices. The connector should conform to the 4-pin connector in the IEEE p~~P~~1394a~~A~~ specification.

If the device uses the 6-pin connector, it should also conform to the specifications for connectors in IEEE p~~P~~1394a~~A~~. It is recommended that all PC peripheral devices implement the 6-pin connector. All host controller ports that are externally accessible should support the 6-pin connector. Consistent use of the standard 6-pin IEEE 1394 connector eliminates an undesirable break in the power bus for power-dependent device applications. Other benefits include volume pricing and consistent electrical performance. Therefore, all external pluggable IEEE 1394 devices must use the standard 6-pin IEEE 1394 connector. The exception is an option to use the 4-pin IEEE p1394a~~A~~ connector for miniature single-port (leaf-node) devices, as defined in the “Only single-port leaf-node devices use 4-pin connectors” requirement later in this section.

Device designers can opt to use the connector described in *the Device Bay Specification, Version 1.0*. If so, the design must be compliant with all connector and electrical requirements of that specification.

25. Self-powered devices propagate the power bus through each connector
Required

Self-powered devices that provide their own power source and do not consume cable power must maintain the electrical integrity of the power bus for other devices dependent on it. Therefore, all self-powered devices must propagate the power bus through each connector. ~~Self-powered devices provide their own power source and do not consume cable power. The exception to this rule is that a self-powered device can consume cable power up to the number of watts defined in *1394 Specification for Power Management* in order to power its own PHY if it is not able to continue to power its own PHY when the self-powered device has been turned off.~~

~~If the self-powered device does consume cable power to power its own PHY, it must always use cable power to do so whenever cable power is present. That is, it cannot dynamically switch between consuming and not consuming cable power for PHY power.~~

~~Self-powered devices that provide their own power source and do not consume cable power must maintain the electrical integrity of the power bus for other devices dependent on it. Therefore, all self-powered IEEE 1394 devices must propagate the power bus through each connector. To accomplish this, each self-powered device must short together the power pins and the ground pins of each connector.~~

26. Only single-port leaf-node devices use 4-pin connectors
Required

The 4-pin connector offers a slightly lower cost and a smaller footprint ideally suited to hand-held devices. Use of a unique leaf-node connector adds one more cable choice for end users. Therefore, devices can comply with this specification by restricting application of the 4-pin (powerless) A/V connector to single-connector leaf-node devices. The 4-pin connector is specified in the IEEE p1394a~~A~~ specification.

27. Device connectors exhibit common speed and power characteristics
Required

Devices with multiple connectors must exhibit common characteristics at each connector to reduce end-user cabling choices. All connectors on a device must exhibit homogeneous speed, power, and mechanical characteristics such that:

- Multiconnector devices use the 6-pin connector.
- All device connectors propagate the power bus.
- All device connectors support a common peak data rate.

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

Optionally, all devices providing cable power through 6-pin connectors must provide diode isolation as specified in the *1394 Trade Association Power Specification Part 1: Cable Power Distribution.*

28. Standard 400-Mb/s rated IEEE 1394 cable provided with devices
Required

For Plug and Play, it is important to use one standard-performance cable for all device configurations to eliminate cable choices for the end user. This is especially important given the range of devices possible on an IEEE 1394 bus. A mix of cable types and ratings creates an unfriendly user experience. Therefore, all cables must be have a minimum 400-Mb/s rating and, if bundled, must be shipped with a standard cable.

Plug and Play Power Interfaces

This section summarizes Plug and Play requirements for cable power distribution.

For Plug and Play, all devices—whether cable or self-powered—must comply with the applicable requirements in *1394 Specification for Power Management.* These requirements enable a power management-capable bus manager to provide instant-on application support while reducing system-wide device power consumption.

In addition, all devices must comply with the *1394 Trade Association Power Specification Part 1: Cable Power Distribution.* Although the requirements for devices that do not consume or produce cable power are minimal, all devices share responsibility for propagating the power bus as defined in the Cable Power Distribution specification.

A standard cable-power distribution model is necessary to reduce the likelihood of power-fault conditions, such as insufficient power for connection of a cable-powered device and surprise removal of a device power source. In addition, a bus manager that is power management-capable can allocate or de-allocate available power within diode-isolated power domains, accounting for the overall power budget and voltage drop.

Plug and Play requirements in this section highlight details specified in the applicable power specifications.

29. Devices provide sufficient power to their PHY at all times
Required

All devices must perform the bus repeater function when powered down as specified in the IEEE p1394~~-1995~~a specification. Therefore, a device power switch must allow for local power to the PHY when switched off. Alternatively, a device can implement the standard protocol to request cable power (if available) from the power manager to power the PHY. The host controller PHY can be

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

powered from auxiliary (Vaux) power such as cable power from another cable source provider or suspend power in the host PC.

~~An exception to these requirements is necessary for PC add-on cards and system-board host connection devices that are subject to the power characteristics of the PCI bus.~~

~~A device that does not provide power to its PHY or consume power from the cable for its PHY will terminate the bus at the point of connection and must, therefore, terminate the pass-through of power.~~

~~Suspended ports must interrupt cable power "flow through."~~

30. Devices report power source and cable power consumption in Self_id packet

Required

Self-powered devices must report zero power consumed in the power class field of the Self_id packet. Alternately, if a device consumes cable power only to keep its PHY alive, it must report this consumption in the Self_id packet. This allows the power manager to reserve power for this occasion.

31. Devices implement link power control

Required

All cable-powered and self-powered devices must implement the Link_on packet and Link_off bit in the State_Clear register. These controls allow a power management-capable bus manager to control the node's power state. Access to the device configuration ROM must be possible following a Link_on. A device cannot increment its power consumption by more than 3 watts following a Link_on. Self-powered devices can power up with Link_on. However, cable-powered devices must rely on the power manager to enable their link.

32. Device requiring power increments in excess of Link_on implements unit-power CSRs

Required

All cable-powered and self-powered devices that require power increments in excess of Link_on power must implement standard unit-power CSRs as specified in *1394 Specification for Power Management.* This is necessary to allow for seamless integration of centralized power management capabilities when a device is connected to a mini-system.

In addition, all devices of a given device class must implement a standard set of unit power states as specified in the device class power management specification for that device class. For example, all VCRs must exhibit a consistent behavior with respect to power states and transitions between states. This is necessary to provide a consistent user experience.

Note: Please check with the 1394 Trade Association or send e-mail to 1394@microsoft.com to determine whether a power class specification exists

for your device type. Alternatively, you are encouraged to draft a proposal for your device type and submit it to the 1394 Trade Association architecture working group for review and approval.

33. Devices that source cable power must report this capability

Required

This reporting is necessary to enable centralized power management. A device that sources 20 volts or more of cable power at 15 watts minimum must report that it provides power in its Self_id packet as specified in IEEE 1394-1995. Devices that provide less than 20 volts at 15 watts can be discovered using configuration ROM information as described in *1394 Specification for Power Management.*

34. IEEE 1394-enabled PC sources cable power

Required

An AC-powered PC must source cable power to the bus. Cable power, in turn, enhances Plug and Play with a single connection for low-cost cable-powered devices. Battery-powered mobile and notebook devices are exempt from this requirement, whether or not the device is connected to an AC adapter.

Minimum power wattage is defined in the following item.

35. Power source supplies a minimum of 20 volts at 15 watts

Recommended

~~To minimize the cost of a power source, actual power output can be reduced to less than 40 volts at 1.5 amps as specified in IEEE 1394-1995. Also, a cable power source should supply enough power for at least one cable-powered device (15 watts) while also addressing voltage drop in the cable. Therefore, a minimum cable power source of 20 volts DC at a current limit of 1 amp is recommended. However, at the expense of higher component ratings, a 30-volt cable power source will reduce power loss in the cable.~~

~~In addition, i~~If the power provider specifies a power capability greater than 15 watts, it must be capable of providing that power under full load. A power provider is required to always be able to provide its stated power under full load conditions.

For example, a minimum 20 watts output will ensure delivery of only 15 watts to a load some distance away from the source device. This is because of a cable voltage drop of 5 volts—that is, 1 amp × 0.66 ohm × 7 to 8 cable hops separating source node from sink node at a rated cable-hop resistance of 0.66 ohms. The voltage at the load will drop to 15 volts, with the source current limited at 1 amp. Therefore, a practical design target for a cable power source is a minimum of 20 volts with a current limit of 1 amp.

A device such as a notebook that wants to source less than 20 volts can do so if it reports in its Self_id packet that it does not source power, but does report in its configuration ROM the exact power it provides.

36. Devices notify the power manager of power change requests

Required

All devices that produce or consume cable power must use an electronic power switch to notify the power manager of requests from the front panel to change the power state. This function must be accomplished using the notification request protocol specified in *1394 Specification for Power Management.* This protocol provides a time-out for defaulting to local control as is necessary for operation in non-power-managed environments.

This same mechanism is required for safe removal of a device (hot unplugging).

Power Management for IEEE 1394 Devices

All devices on the IEEE 1394 bus must comply with the power management requirements outlined in this section.

37. Devices and controllers comply with Cable Power Distribution specification

Required

The cable power distribution model has been defined to provide guidelines for implementation of devices that propagate, source, or sink cable power. Thus, all devices must satisfy power distribution requirements. *1394 Trade Association Power Specification Part 1: Cable Power Distribution* addresses interoperability and power distribution necessary for operation of both power-managed bus configurations and, with some restrictions, unmanaged bus configurations.

38. Devices and controllers comply with IEEE 1394 power specification

Required

Power-management CSRs and protocols provide an enhanced Plug and Play experience for end users. All devices must support power-state, power-capabilities, and power-status commands as defined in *1394 Specification for Power Management.* Cable-power devices must support the notification request protocol. Wake-up and battery-status CSRs are optional but recommended.

Published: April 24, 1997. Printed: 04/24/98 9:51 AM

IEEE 1394 References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

1394 Specification for Power Management
ftp://ftp.p1394pm.org/pub/p1394pm/
http://www.microsoft.com/hwdev/onnow.htm

1394 Trade Association
E-mail: 1394-sig@1394ta.org
http://www.1394ta.org

1394 Trade Association Power Specification Part 1: Cable Power Distribution
ftp:// ftp.p1394pm.org/pub/p1394pm/

IEC 61883 Digital Interface for Consumer Electronic Audio/Video Equipment
http://www.iec.ch

IEEE 1394 Standards
ASK*IEEE
Telephone: (800) 949-4333
Fax: (212) 310-4091
E-mail: askieee@ieee.org

Global Engineering Documents
Phone: (800) 854-7179 (US)
(613) 237-4250 (Canada)
(303) 792-2181 (Outside North America)
Fax: (303) 397-2740
ftp://ftp.symbios.com/pub/standards/io/

Information about IEEE 1394 implementations
http://developer.intel.com
http://www.microsoft.com/hwdev/busbios/

Open Host Controller Interface Specification
ftp://www.austin.ibm.com/pub/chrptech/1394ohci/

Plug and Play specifications
http://www.microsoft.com/hwdev/respec/
Vendor ID registration: pnpid@microsoft.com

Windows NT DDK
MSDN Professional membership

Checklist for IEEE 1394

If a recommended feature is implemented, it must meet the PC 99 requirements for that feature as defined in this document.

1. Controllers and devices support mandatory features in IEEE p1394a with backward compatibility with IEEE 1394-1995
Required

2. Controllers comply with OpenHCI for IEEE 1394
Required

3. OpenHCI controllers and devices support advances defined in IEEE 1394a
Required

4. Host supports peak data rate of 400 Mb/s, minimum
Required

5. Design avoids excessive currents resulting from ground-fault potential among devices
Recommended

6. Device command protocols conform to standard device class interfaces
Required

7. Devices support peak data rate of 400 Mb/s, minimum
Required

8. Devices requiring support for high-bandwidth data transfer use IEEE 1394
Recommended

9. Plug and Play devices demonstrate interoperability with other devices
Required

10. Topology faults do not cause the bus to fail
Required

11. Removable media devices support media status notification
Required

12. Devices that can initiate peer-to-peer communications also support remote programming
Required

13. Device provides a configuration ROM for unique device identification
Required

14. Device configuration ROM implements general ROM format
Required

15. Bus information block implemented at a base address offset of 0404h
Required

16. Configuration ROM provides globally unique device ID
Required

17. Root directory is located at a fixed address following the bus information block
Required

18. Configuration ROM includes a unit directory for each independent device function
Required

19. Each unit directory provides a valid Unit_Spec_Id and Unit_Sw_Version
Required

20. Each unit directory provides a pointer to a unit-dependent directory

Required

21. Vendor and model leaves support textual descriptor leaf format
Required

22. Unit-dependent directory provides a pointer to the unit's CSRs
Required

23. Device provides more than one connector port
Recommended

24. Device uses the approved IEEE 1394 connectors
Required

25. Self-powered devices propagate the power bus through each connector
Required

26. Only single-port leaf-node devices use 4-pin connectors
Required

27. Device connectors exhibit common speed and power characteristics
Required

28. Standard 400-Mb/s rated IEEE 1394 cable provided with devices
Required

29. Devices provide sufficient power to their PHY at all times
Required

30. Devices report power source and cable power consumption in Self_id packet
Required

31. Devices implement link power control
Required

32. Device requiring power increments in excess of Link_on implements unit-power CSRs
Required

33. Devices that source cable power must report this capability
Required

34. IEEE 1394-enabled PC sources cable power
Required

35. Power source supplies a minimum of 20 volts at 15 watts
Recommended

36. Devices notify the power manager of power change requests
Required

37. Devices and controllers comply with Cable Power Distribution specification
Required

38. Devices and controllers comply with IEEE 1394 power specification
Required

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